able size, and receives a river at its west end, the Upper Alexandra Nile, which probably comes from a considerable distance. Mr. Stanley believes that the Alexandra Nyanza has a marshy connection with Kivu Lake on the south, from which issues the Rusizi, an affluent of the Tanganyika. If then these various connections are ultimately verified, the problem of African hydrography becomes more complicated than ever. The Rusizi will connect the Nile system with Tanganyika, and very shortly, at least, Mr. Stanley believes, the Lukuga will carry the water of the latter to the west—to the Congo, say some. Meantime Mr. Stanley is probably at or has already left Nyangwe. After deciding this question of the connection of Albert and Tanganyika Lakes from that side, he will probably devote himself to the task of tracing down the Lualaba, which, according to Cameron, should bring him into early communication with Dr. Nachtigal, who is to trace up the Congo.

It may not be uninstructive to point out what is the present state of the problem which these two explorers have set themselves to solve. Our principal scientific authorities on the Congo are still Capt. Tuckey and Prof. Smith, who in 1816 ascended about 200 miles up the river, and who have left us a record yet deserving of study. They left England at a time when the outlet of Mungo Park's Niger was a subject of speculation, and amongst the theories then started, the Congo, as an outlet, held a high place. The same notions of the magnitude of this river obtained then, and Capt. Tuckey and his civilian scientific staff started with the idea that they would be able to navigate it for hundreds of miles. They had, however, only been in the river some four or five days when Prof. Smith makes this entry in his diary :—"The channel is very narrow and the current never more than three knots . . . everthing yet seems to indicate that the descriptions of the great breadth of the river, the length of its course, &c., have been exaggerated." Again, twelve days afterwards, when they had got considerably further up the river, he writes, "The whole appearance of the river, its numerous sandbanks, low shore, inconsiderable current, narrow channel, seem but little to justify its extravagant fame. Its sources cannot be further inland than those of the Senegal and Gambia." Capt. Tuckey, who ties himself very rigidly to a statement of facts, ventures to say that at Fathomless Point the true mouth of the river "is not three miles in breadth ; and allowing the mean depth to be forty fathoms and the mean velocity of the stream four and-a-half miles an hour, it will be evident that the calculated volume of water carried to the sea has been greatly exaggerated." The mean velocity of the current higher up the river than the true mouth appears to be about two miles, and Tuckey remarks that they found no difficulty in rowing the gigs to the foot of Casan Yellala *against the current*.

These falls or rapids (Yellala) deserve some notice. They extend continuously for about twenty miles along the river, and are very much like the rapids on the Somerset Nile between Foweira and Magungo, where Col. Gordon reports a fall of 700 feet in a space of ten or fifteen miles. On August 14, 1816, Prof. Smith says, "We discovered the celebrated fall of Yellala, at a distance of about a mile and a half. But how much were we disappointed in our expectations on seeing a pond of water only with a small fall of a few hundred yards." They had been led to expect a second Niagara, and instead of that, found a rapid having a perpendicular fall of thirty feet in a slope of 300 yards formed of a descending bed of mica slate. The width of the river is very various, sometimes expanding to half a mile. It is compared by Tuckey to Loch Tay and by Smith to the Drammen, in Norway, at the bridge. Sometimes it contracts to 100 yards ; in one place it is reduced to fifty yards in breadth, but at this point the stream rushes through at the rate of eight miles an hour. The rapid and considerable rise of the water during the rainy season is largely accounted for by the fact that "the hills do not absorb any of the water that falls, the whole of which is carried direct to the river by gullies and ravines, with which the hills are furrowed all over." These hills are composed entirely of slate, with masses of quartz and syenite, and their extreme barrenness forms one of the most striking features of the country.

It would appear from Capt. Tuckey's and Prof. Smith's reports that the farthest point they reached on the river was at least 1,000 feet above the sea, and as this point is about 800 miles in a direct line from Nyangwe, which Cameron has fixed at 1,400 feet, the connection between the Congo and Lualaba on the question of level alone seems very doubtful.

The Casai and Kwango are doubtless the chief affluents of the Congo ; it may have tributaries from the north and north-west behind the coast ranges, but these will be of secondary importance. As soon as we get east of the Congo water-parting, we begin to descend to the great valley of the Lualaba, Livingstone's "central line of drainage." This river occupies the centre of a saucer-like depression, one lip being probably the Congo water-parting, the other the Bambarre, or perhaps Kabogo Mountains to the west of Tanganyika. The fall of this depression is from south to north ; commencing at the Katanga copper mines of the Pombeiros, it runs to Lake Kassali 1,750 feet, to Nyangwe 1,400 feet ; thence to the "Unvisited Lake" of Livingstone, the "Great Lake" of Poncet, or the "Sankorra" of Cameron, probably also the "Liba" of the Benin slaves, and so on by the Shari to Lake Chad, 830 feet.

From these statements, then, it will be seen that the solution of the hydrographical problem of Western Central Africa is difficult to arrive at on the data we at present possess, and that to advocate any special theory may be rash. The Congo theory is a fascinating one, but the levels seem against it. However, with two such men as Nachtigal and Stanley in the field, the solution of this problem, as of others almost equally interesting, will soon be discovered.

THE LONDON INDUSTRIAL UNIVERSITY

WE give below a series of extracts from an admirable letter addressed by Major Donnelly, the chief of the scientific staff of the Science and Art Department, to Sir Sydney Waterlow, with reference to the proposed Industrial University to be established by the City Guilds in London :—

London, March 14, 1877

DEAR SIR SYDNEY WATERLOW,—In reply to your request, I am happy to place at your service such suggestions, with regard to the proposed "City Guilds' Industrial University," as my experience in connection with the Science and Art Department enables me to offer. . . .

Under anything like a broad view of the subject it would be difficult to say what branch of learning should be omitted in an Industrial University. But if we confine ourselves to what is practicable with the probable means immediately at command, and if we look to commence by supplying that of which there is the greatest want, we shall, I think, have no hesitation—considering the relative facilities for obtaining instruction in the different branches of knowledge—in deciding that science as now understood, and particularly Applied Science, has the first call on our attention.

. . . The Industrial University might be *commenced* by establishing professorships with the necessary laboratories, tutorial staff, &c., in the following branches of Science and Art :—

Mathematics (Pure and Applied and Practical Geometry).
Chemistry.
Physics (Heat, Light, Magnetism, and Electricity).
Mechanics (Practical Mechanics, Machinery, and Machine Drawing).
Engineering and Building Construction ; and in

Applied Art (Modelling, Designing, Enamelling, Repoussé work, Wood Carving, &c.).

As the teaching would be specially directed to the industrial applications of science it is needless to say that considerable subdivision would be required in the subjects named. . . .

. . . It is of great importance that the professors should be not only teachers, but investigators, constantly endeavouring to enlarge the field of accurate knowledge, and scientific procedure, in our industries. To appreciate how much may be effected in this way we have only to consider the millions saved to France by Pasteur's researches on the disease of the silkworm, or the knowledge obtained by his inquiry on fermentation.

. . . The time of the professors may be much economised by making it no part of their duty to commence their courses with the elements of general science. It is quite unnecessary that they should do so. This teaching may be obtained at other places, with which the Industrial University would be only needlessly interfering if it gave elementary instruction. It should, on the contrary, be its object to supplement and specialise the knowledge obtainable in ordinary science classes from which the students should be drawn; and they should be expected to have acquired sufficient general knowledge of science before entering the classes and laboratories of the University to be able to follow its courses with advantage.

A leading feature of the University should be evening courses—not merely popular lectures—for the use of those whose circumstances in life have rendered it necessary that they should commence the practical work of life early. By circumstances in life I do not refer solely to poverty. There are many occupations that it is advisable, if not necessary, to enter upon early. For instance, it is of the utmost importance for a mechanical engineer to be a good practical workman. To do this he must join the workshop when young. And the lad who enters when he is thirteen has an advantage which might not be expected. Mr. Phythian, the Master of the Oldham School of Science and Art established by the Messrs. Platt, informs me that to the lads who come into the workshop at this age the evening intellectual work is no effort; it is a relaxation and recreation. To the apprentices who enter at eighteen it is almost an impossibility. They are so exhausted by their day's labour that they cannot pay attention.

It is agreed on all hands that if the teaching of science is to be of any use it must be essentially practical—that is to say, the teaching of the laboratory. And no pains should be spared to make the laboratories perfect and readily available. By them the University may supply a great want.

It is perhaps necessary to guard against the idea that the University is to teach any trade or business. There could be no greater mistake than for it to attempt to do so. The purely technical knowledge of a trade must be learnt by practising it. The teaching of a public institution can with advantage only extend as far as the special application of various branches of abstract science to the different arts. It is no doubt difficult to define how far the teaching of applied science may go without trenching on the workshop. But in practice the limits are readily found. This difficulty will be still less felt in an institution drawing its pupils from among those actually engaged in trade, who will know what they can acquire in the University, and what they can better learn directly in business. The programme of examinations in technology by the Society of Arts will give many suggestions on this subject.

I have no doubt that the Society of Arts would be willing to transfer the whole or a part of their system of examinations in technology to such a body as the City Guilds, who, with far larger funds at their disposal, may give it a development which the Society of Arts can never obtain for it. By employing local agencies and taking advantage of the machinery of the Science and Art Department, these examinations are held throughout the country. And by availing itself of this and similar organisations, the Central University might be brought *en rapport* with every part of England, Scotland, and Ireland.

. . . Through the action of the Government, stimulating local effort, the country is being rapidly covered by a network of Science and Art schools and classes, where the working classes—whose interests and advances the City Guilds are, I understand, especially anxious to promote by the Industrial University—have opportunities of obtaining that elementary instruction in Science and in Art which must be the basis of any sound technical education. There are now 1,750 separate schools or classes in the country in connection with and receiving aid through the Science and Art Department.

It is therefore unnecessary to consider the question of the creation of any organisation for giving instruction in elementary general science or art. What are wanted are a stimulus to increase the number of students, the development of systematic courses of instruction onwards and upwards from the elementary school, and means to enable poor, but clever and industrious, youths to pursue such courses. The award of small scholarships or bursaries in competition which would support the holders while carrying forward their studies in a higher school—the retention of the bursary being contingent on a definite course of instruction being pursued satisfactorily—is therefore, I believe, the most effective means the Guilds can adopt to aid technical instruction.

. . . It is very necessary to bear clearly in mind in what directions the University must look for its pupils. Broadly speaking, these will I believe be :—

1. The holders of Bursaries and Scholarships.

2. Young men whose means enable them to carry on their education beyond the school age, and who can attend an institution in London more conveniently than elsewhere.

3. A limited number of students of the same class who are attracted by the goodness of the instruction and its appropriateness to their future pursuits. I say a limited number, because, however good the instruction, it will take years to divert the class of students from the channels which time has consecrated.

4. Evening students—men who are engaged during the day.

It would be useless to expect many students from classes 2 and 3 at first. . . .

The real point seems to me to make a beginning. Get a good site—by a good site I mean a site in an accessible position, sufficiently large to allow of expansion as the University grows—build chemical and physical laboratories, and lecture rooms, and some mathematical class rooms, on a portion of the site. If these are well managed, and are in a prominent position, such as that suggested on the Embankment, where they cannot but be seen—it is difficult to make anything known in London—surely there must be many rich men in the city besides the city companies who will seize the opportunity, by adding to the endowment or the buildings, of perpetuating their memories as munificent patrons of what will eventually be a credit to the country.

. . . It always seems to be forgotten that the population of London is as large as that of Scotland; and that if its provision for instruction were tenfold what it is, it would not be proportionately larger than that of the Canton of Zurich.

Any plan you commence upon must be much modified as the institution is expanded and developed. To succeed, the University must be built up by slow degrees and adapted, with the experience you gain from day to day, to meet the wants and circumstances of the time. That it will be a success, and a great success, if taken heartily in hand by the City of London, there can be no doubt.

Believe me,
Yours very faithfully,
J. F. D. DONNELLY

OUR ASTRONOMICAL COLUMN

THE OPPOSITION OF MARS IN 1892.—Early in August, 1892, the planet Mars will come into opposition at a distance sensibly the same as in September of the present year, when it is proposed to make a serious attempt to determine the solar parallax by observations of this planet, a method which has not hitherto been applied under such advantageous circumstances as are now possible, but which is calculated to furnish the sun's distance from the earth with a degree of precision comparable with that to be attained by the observation of a transit of Venus, and with far less trouble and expense. It will not perhaps be without interest at the present moment, when the attention of astronomers is particularly directed to the efficient observation of Mars near the opposition in September next, if we present an ephemeris for the opposition of 1892, the only one of the present century yet to come, which can be to all intents and purposes as favourable as that of 1877. The ephemeris is founded upon the tables of M. Leverrier, which have been applied with sufficient accuracy for the object in view. The positions are for mean noon at Paris.